Research Note

An aberrant sinistral *Conus* (Neogastropoda: Conidae) from the Miocene of Florida, USA

INTRODUCTION

Nearly all members of the hyperdiverse genus *Conus* typically exhibit dextral, or right-handed, shell coiling. Sinistral, or left-handed, shell coiling is a species-level characteristic of an extinct taxon—*Conus adversarius* Conrad, 1840—from the southeastern United States (see Hendricks 2009a, b), but sinistral coiling is otherwise known from fewer than 30 individuals from seven extant, typically dextral species (Hendricks, 2009b). Given the tremendous interest and energy that has been put into the collection of cone shells over the last several centuries, as well as the remarkable diversity of the genus (over 1,500 fossil and extant species; Röckel et al., 1995), these small numbers of confirmed reverse-coiled *Conus* are remarkable. Here we present the first record of an aberrant sinistral *Conus* fossil from an extinct species and briefly discuss its significance.

MATERIALS, METHODS, RESULTS, AND DISCUSSION

The sinistral *Conus* fossil (Figure 1)—UF 137855, Florida Museum of Natural History, Division of Invertebrate Paleontology—was collected from the lower Miocene Chipola Formation (~18 Ma; Bryant et al., 1992; Jones et al., 1993) at Tenmile Creek, Calhoun County, Florida, USA (UF locality CA020). Specimen UF 137855 is broken and abraded, preventing us from making a definitive identification, but several features suggest that it is probably a specimen of the typically dextral species *Conus vegrandis* Hoerle, 1976 (see Hoerle, 1976, table 1, for a listing of characters that separate *C. vegrandis* from co-occurring Chipola species). These features include: spire and body whorl outlines that are slightly sigmoid in profile; the presence of raised spiral cords on the anterior half of the body whorl; and the thin, ridge-forming carina on the shoulder of the body whorl noted by Hoerle (1976) in her original description of the species (this feature is not present in *C. adversarius* and negates the possibility that UF 137855 is an individual of that younger Plio-Pleistocene species). The apex of UF 137855 is eroded, preventing us from characterizing its protoconch and early postnuclear whorls. A paratype (UF 171658) of *C. vegrandis* from the same locality as UF 137855 is shown in Figure 2.

Hendricks (2009b) noted that all sinistral individuals of otherwise dextral extant taxa with known developmental modes belong to species with lecithotrophic larval development. He also showed that this was the case for *C. adversarius*, and was likely important to the initial origin and establishment of that species. One of us (JRH) observed the protoconchs (Figure 3) of five specimens of *C. vegrandis* using a FEI Quanta 200 scanning electron microscope at San Jose State University and, from the resulting images, measured the diameter of each protoconch, as well as its number of whorls (counted using the methodologies described in Jablonski and Lutz, 1980, and Tursch and Greifeneder, 2001, both of which gave similar results). On average, protoconchs of *C. vegrandis* had diameters of about 0.76 mm (range of about 0.73 to 0.82 mm) and about 1.9 whorls (range about 1.7 to 2.1 whorls). These data were then considered in the context of Shuto's (1974) model for predicting developmental mode based on protoconch diameter and number of whorls, which has been previously applied to *Conus* by Kohn and Perron (1994) and Hendricks (2009b). All five specimens fall within the lecithotrophic portion of Shuto's (1974) model (see Hendricks, 2009b, fig. 2), suggesting that *C. vegrandis* had that developmental mode. Thus, the association between sinistral shell coiling and lecithotrophic development also appears to hold true for *C. vegrandis*.

Grande and Patel (2009) recently showed that the genes *nodal* and *Pitx*, which relate to left-right morphological asymmetries in deuterostomes, are also present in gastropods (lophotrochozoans), and their position of expression in the developing embryo corresponds to shell coiling direction. Nevertheless, the single maternal effects locus (see Ueshima and Asami, 2003; Schilthuizen and Davison, 2005; Davison et al., 2009) responsible for chirality in gastropods remains undiscovered. The discovery of specimen UF 137855 provides phenotypic evidence for the first time that the sinistral allele was present in *Conus* by ~18 Ma, offering a small amount of insight into the genetic makeup of this extinct species.

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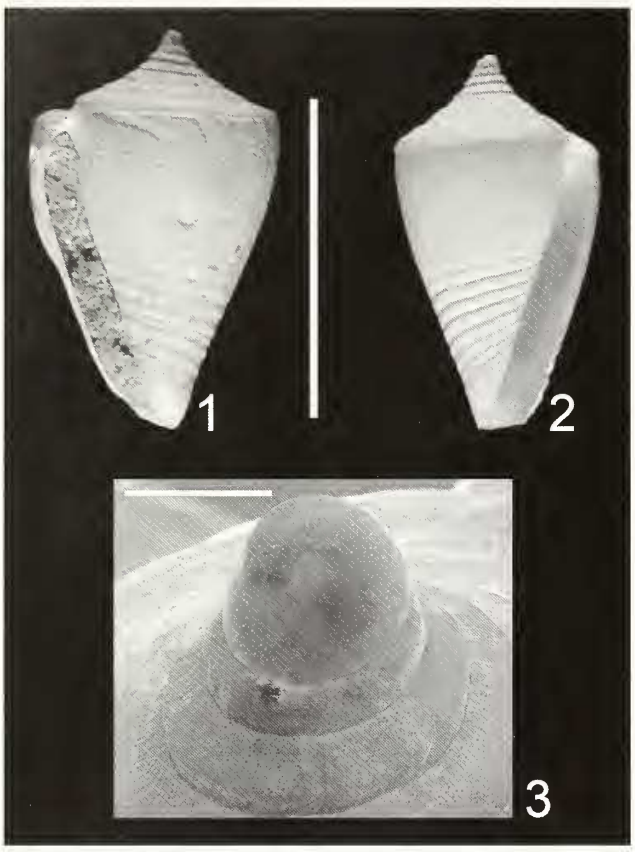

Figures 1–3. Specimens of *Conus vegrandis* Hoerle, 1976. **1.** UF 137855, sinistral specimen of *Conus* cf. *vegrandis*; shell length = 12.6 mm. **2.** UF 171658, paratype, typical dextral specimen; shell length = 11.8 mm. Both specimens are from the lower Miocene Chipola Formation of Tenmile Creek, Calhoun County, Florida, USA (UF locality CA020). Scale bar (Figures 1, 2) = 1 cm. **3.** UF 173382, scanning electron micrograph of the protoconch and tuberculate early postnuclear whorls of a specimen from the lower Miocene Chipola Formation of Tenmile Creek, Calhoun County, Florida, USA (UF locality CA017). Scale bar = 0.5 mm.

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